Chapter 9

Adaptive Management, Monitoring, Inventory and Research

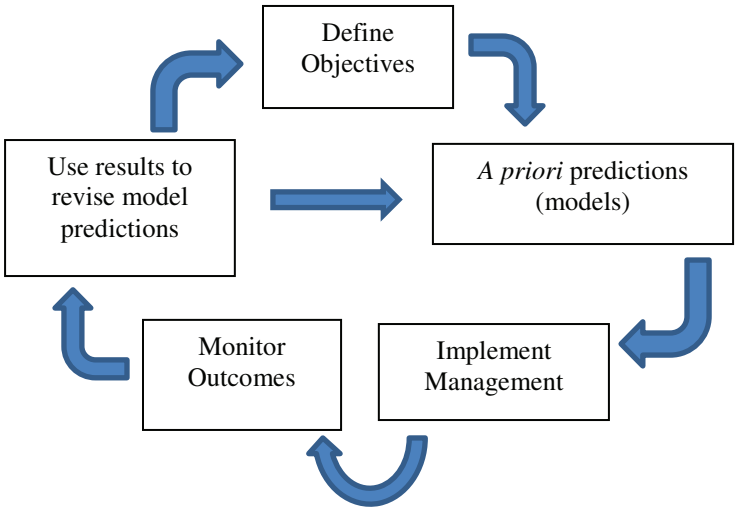
In this chapter, we present a framework for adapting our conservation actions in response to new information and changing conditions. The Nebraska Natural Legacy Project's adaptive management framework strives to improve our understanding of how systems in Nebraska work. Management objectives should be achieved through a process that involves stakeholders, is transparent and inclusive, acknowledges uncertainty about the system and the potential impacts of conservation actions, makes use of management actions and follow-up monitoring to promote understanding and improve subsequent decisions, and improves the consistency of implementing conservation actions. Our approach will involve exploring alternative ways to meet management objectives, predicting the outcomes of alternatives based on the current status of knowledge, implementing one or more of these alternatives, monitoring to learn about the impacts of the actions, and using the results to update knowledge and adjust management actions. In addition to maximizing our implementation efficiency, we are striving to make the best choices given our financial resources.

An integral component of adaptive management is monitoring to assess species and habitat responses to management actions (Figure 1). We present a number of components that should be included in a monitoring plan, the development of which is one of the priorities in implementing the Nebraska Natural Legacy Project. In addition, we list priority inventory and research needed to fill critical data gaps, provide baseline information for monitoring, and provide the knowledge needed to develop more effective conservation actions.

Adaptive Management

Adaptive management is the process of continually improving management policies and practices by learning from the outcome of management actions. Broadly, adaptive management requires defining specific objectives, making a priori predictions (i.e., constructing models) about the effects of one or more management actions on those objectives, implementing management actions, monitoring outcomes, using results to revise model predictions and management actions, and then repeating the process in an iterative loop. Adaptive management seeks to speed up the learning process about cause-and-effect relations between management actions and outcomes thus, allowing managers to make more effective decisions in a shorter time.

Figure 1.



The fundamental motivation for using adaptive management is that the impact of management actions on resources is uncertain, and the reduction of that uncertainty will accelerate progress in meeting management objectives over time. Not all decisions can or should be adaptive. In some cases there is no opportunity to apply learning. In other cases, there is little uncertainly about which action to choose. Several conditions must apply:

1. The action must be important enough such that action will occur.
2. There must be institutional capacity and commitment to undertake and sustain an adaptive program.
3. Application of adaptive management must involve a real choice among management alternatives.
4. It must be possible to acquire understanding quickly enough to apply it to subsequent management decisions.
5. The resource management decision must be such that it can be re-visited over time and modified.

In its simplest form, adaptive management can involve applying a conservation action at a site, observing the results and adjusting the action in the future if warranted. However, it has its widest applicability when components of experimental design are incorporated into the monitoring process including replication, random assignment of treatments (including controls) and sites, and statistical analysis of results. Monitoring and evaluation provide the critical links between implementing conservation actions and revising management objectives and actions to be more effective. A feedback information loop will connect habitat work with species and/or habitats and links existing literature, research, and researchers with conservation practitioners.

Adaptive management can be a powerful tool for adapting to climate change because the current levels of uncertainty, the potentially rapid rate of change, and the rate of increase in knowledge will necessitate frequent evaluation and adjustment in conservation actions. Any strategy for managing the effects of climate change on species and ecosystems should be deployed within an adaptive management framework to enable managers to learn from previous management activities and to respond quickly and creatively to the challenges posed by climate change.

The mountain plover *(Charadrius montanus)* nest marking program is an example of an adaptive management project that identifies the issues that negatively impact a specific species, identifies and conducts priority research, and improves conservation actions accordingly. The mountain plover is a threatened species in Nebraska. The first conservation action for the mountain plovers was to survey the panhandle of Nebraska to estimate the abundance and location of nesting pairs. After this initial survey, many more pairs were detected than anticipated, but nests were primarily in agriculture fields on private lands. In neighboring states, this species typically nests in short-stature grasslands and prairie dog towns. An identified threat in the first addition of the Natural Legacy Project for mountain plovers was "agriculture practices" and a research question was to evaluate "the impact of nesting in agriculture fields vs. native grasslands on mountain plover productivity." Action was taken to reduce the threat of nests being destroyed by tillage, through a nest marking program developed in cooperation with the Rocky Mountain Bird Observatory. The nest marking program works with willing landowners to detect and mark nests in agriculture fields and provides landowners incentives to till around the marked nests. From 2005 to 2007, the nest marking program was evaluated and was successful, with less than 3% (7/246) of marked nests failing because of tillage (20% total nest failure rate). In 2007, 65% (34/52) of unmarked artificial nests (i.e., scrapes with similar-sized eggs painted to look like mountain plover eggs) failed (no eggs survived) because of tillage. The program was also a success because landowners became knowledgeable of mountain plovers and were interested in continuing the program. The next phase is to understand if chick survival in "nest marked" crop field is high enough to sustain or increase the resident population. Initial results of this study suggest that chick survival is high in crop fields participating in the nest marking program relative to native habitats, but another survey year is needed to determine if the nest marking program should be continued.

The next steps for integrating adaptive management principles into implementation of the Natural Legacy Project include:

- Development of plans that identify the goals and objectives at local and/or regional scales
- Identify priority questions appropriate for the application of adaptive management
- Collaborate with resource managers for implementation of adaptive management

Monitoring

During the initial development of the Nebraska Natural Legacy Project, we did not have the resources necessary to develop a detailed monitoring plan. Below we have identified a framework for developing such a plan, which is important to implementation. Because of limitations of human, financial and information resources, we must be strategic in selecting both what to monitor and how to monitor it. Monitoring of management actions is typically conducted at two levels: 1) response of individual species and 2) response of habitats or natural communities. In addition to monitoring biotic responses, one can monitor whether proposed conservation actions were carried out (implementation monitoring), the public/stakeholder understanding, acceptance and support of conservation actions, and/or the abatement of key threats to species or communities. To be successful, a monitoring strategy needs to be affordable, provide credible information that assesses effectiveness and is usable by decision makers.

There is a need to develop long-term monitoring systems that are strategically designed to evaluate climate change impacts and species and ecosystem responses. With so much uncertainty surrounding the impacts of climate change and how species and ecosystems will respond, it is vital to design and implement monitoring programs that can provide the best science-based information possible. Results can be used to better inform decision makers and habitat managers on the best adaptation strategies. Monitoring for climatic change and associated impacts can be carried out as a stand-alone effort or by integrating relevant variables into existing monitoring efforts.

Implementation Monitoring

An important component of the monitoring strategy will be to track the implementation of conservation actions that are proposed in the Nebraska Natural Legacy Project. These can be used to evaluate how well the goals set for conservation of natural communities and species are being met. Information collected would include the location, types of conservation actions, agencies and organizations involved, species and communities affected, acres or miles of stream, cost of project, funding sources, etc. The use and effectiveness of tools such as incentives, easements, voluntary acquisitions, management agreements, and restorations should also be monitored and analyzed, not only in terms of accomplishments but also cost-effectiveness.

Species Monitoring

Population monitoring is currently being conducted on a regular basis, mostly annually, for a handful of at-risk species including bald eagle (Jorgensen et al. 2010), piping plover (Baasch 2011, Brown & Jorgensen 2010, Elliott-Smith et al. 2009, Tacha et al. 2011), interior least tern (Baasch 2011, Brown & Jorgensen 2010, Tacha et al. 2011), greater prairie-chicken (Lusk 2011), pallid sturgeon (Drobish 2008, Welker & Drobish 2010), and Salt Creek tiger beetle (Spomer and Fritz 2011). This type of monitoring allows researchers to determine if populations are increasing, stable, or decreasing and can alert staff to the need for action in the case of declining populations. This type of monitoring is most effectively conducted prior to and following management actions to assess the impacts of these actions and modify the actions to maximize the desired effect on species

of interest. Given the expense of detailed population monitoring, a careful evaluation will need to be conducted to determine which additional at-risk species should be monitored, as well as if the currently monitored species warrant continued evaluation.

Standardized monitoring protocols exist for some well-studied species and should be used in order to maintain the compatibility of data gathered here with that gathered in other states. If no established protocols exist, they should be developed from what is known about the species. Monitoring protocols need to be specifically tailored to the species and management actions being evaluated. Monitoring should be designed to quantify population change and to understand the potential causes of the change.

Monitoring factors might include direct measurements of populations or indirect measures such as habitat. Direct measures might include population size, density, growth/condition, productivity, or survival. Habitat can be used as a surrogate for direct population measures if the relationship between habitat and population is well defined. In many cases, a combination of direct and indirect measures will be appropriate. In addition, habitat data are critical to the understanding of causes of population change.

The overall conservation status of species will also be monitored. The Tier I and Tier II at-risk species lists will be periodically reviewed and revised by taxon experts. This revision will occur on an ongoing basis as new information on abundance, distribution, and population trends becomes available.

Habitat Monitoring

Habitat monitoring can occur at two main levels: monitoring trends in abundance, distribution, and condition of individual community types and 2) monitoring the response of community examples to management action, including restoration.

Monitoring trends in abundance and distribution of different habitat types can be used to detect land use changes and can help direct conservation action toward those types that are showing the steepest decline. A map of historic vegetation (Kaul and Rolfsmeier 1993) can be used to evaluate the change in abundance since pre-Euro-american settlement, while more recent trends can be examined using current surveys. This type of monitoring over a large scale is best accomplished using remote sensing techniques. There is a need to develop a set of best management practices for natural communities that maintain and enhance their biodiversity value. Monitoring responses of individual community types to various management practices will be a key component in developing those guidelines. Both formal experimentation testing different management practices, as well as monitoring existing practices on managed lands, will be needed. Floristic quality assessment is one approach that may be used for evaluating responses to treatments. One could also monitor responses of indicator species or exotic species within the community.

Databases

The Nebraska Natural Heritage Program maintains the most comprehensive, statewide database on at-risk species and natural communities. Information on at-risk species from other Nebraska Game and Park Commission databases (Fisheries, Nongame Bird Progam, Nongame Mammal Program) has been added to this database. Currently, there are more than 11, 000 species records and 1,700 community records in the Natural Heritage database. This database is updated annually with new survey information from agency staff, university researchers, and biologists from conservation organizations. The Heritage database is linked to the Biologically Unique Landscapes layer (see Chapter 3) and will automatically update information on the landscapes as new survey information becomes available.

All data added to the Heritage database are quality controlled and converted to a standard format. The quality control process ensures that the data are accurate and reliable, while the standard format allows data from many sources to be easily queried, summarized, and distributed. In addition, because the same standard format is used by programs in the Natural Heritage network (all 50 states, all Canadian provinces and several Latin American countries), the data can be easily combined into large datasets that allow for analyses across state and national boundaries. These multi-jurisdictional datasets allow for effective broad-scale conservation planning. Data standards as well as multi-jurisdictional datasets are developed and maintained by NatureServe in conjunction with its member Heritage Programs and Conservation Data Centres.

Additional databases can be used to help track progress towards meeting the goals of the Natural Legacy Project. One recently developed database tracks implementation of conservation actions on an annual basis. Information tracked includes conservation goals, type of action(s), species and habitats affected, location, number of acres or miles of stream affected, project cost, and funding sources.

Inventory and Research

Development of the Nebraska Natural Legacy Project was hampered by lack of information in a variety of areas including species and natural community data, appropriate conservation strategies, and best management practices. In addition to inventory and research that may be conducted as a part of monitoring, there is a need to fill critical information gaps on the distribution, abundance, conservation status, threats, biology and ecology of at-risk species and natural communities. Below is a list of priority inventory and research projects that are needed to fill critical data gaps, provide baseline information for monitoring, and provide the knowledge needed to develop more effective conservation actions.

Biological Inventory

Species

- For a number of the Tier I species, there were not enough documented occurrences of populations to fully meet the goals set for those species. Inventory of additional populations of these species should be a priority. There is also a strong need to assess the condition/viability of each population during inventory work. Appendix 8 identifies inventory and research needs for individual Tier I species.

- Conduct inventory work to better document the distribution and abundance of Tier II at-risk species. Inventory work should be prioritized based on gaps in knowledge and the imperilment status of the species. In general, our inventory needs are greatest for invertebrates (both terrestrial and aquatic) and non-vascular plants.

- Develop predictive models of species distribution for at-risk species to guide survey work and increase inventory efficiency.

- Inventory the distribution and spread of key invasive species including garlic mustard, purple loosestrife, Eurasian phragmites, Russian-olive, saltcedar, and zebra mussel.

- Conduct long-term monitoring studies to evaluate changes in distribution and abundance of selected Tier I species that have been assessed to be highly vulnerable to climate change.

Natural Communities

- There were insufficient documented occurrences of some of the natural community types to fully meet the goals set for those communities. Inventories identifying high-quality examples of each of these types should be a high priority.

- Develop a classification for aquatic systems (lakes, rivers, streams). Conduct inventories to identify high-quality examples of each type.

Landscapes

- Inventory priority landscapes for additional high-quality examples of Tier I species and natural communities. Identifying other occurrences at these existing sites will increase the efficiency of the conservation effort. For example, the Central Loess Hills BUL has been identified as a high priority for inventory work.

Biological Research

Species

- Conduct research to better understand the biology/ecology of at-risk species. Appendix 8 lists research needs for individual Tier I species.

- Evaluate the habitat requirements of at-risk species including the size, condition and landscape context of habitat(s) needed to sustain viable populations.

- Evaluate the feasibility and efficacy of captive rearing. Develop captive rearing techniques for highly imperiled species that will require re-introduction efforts to recover the species (e.g., Salt Creek tiger beetle).

- Conduct studies to evaluate the impact of invasive species on native flora and fauna.

- Evaluate the invasive threat potential of candidate invasive species.

- Develop control mechanisms for invasive species that have a high impact on at-risk species and natural communities.

- Conduct climate change vulnerability assessments for selected Tier II species.

Natural Communities

- Increase understanding of ecological processes influencing communities; investigate grazing, fire, and hydrology, and the natural mosaic of disturbance and patch types in a landscape.

- Identify thresholds for ecosystem-function impairment that affect the viability of at-risk species and biological diversity.

- Conduct studies to evaluate the effects of management practices (e.g., burning, grazing, haying, hydrologic manipulation) on the composition, structure and function of natural communities.

- Develop best management practices to promote native species diversity and maintain ecological processes in different community types.

- Develop habitat restoration techniques for those community types for which there is the greatest need of restoration and the least known about restoration (e.g., saline wetlands, freshwater streams).

- Conduct studies to evaluate the success of habitat restoration projects.

- Conduct climate change vulnerability assessments for selected natural community types.

Conservation and Environmental Education Research

- Determine the most critical and requested education materials and develop a priority listing for areas of needs.

- Determine the need for additional educators who are trained in nature education.

- Conduct an inventory of outdoor education and nature centers in Nebraska and identify areas of the state that would benefit from new centers.

Nature-based Recreation Research

- Conduct statewide and regional economic impact studies of hunting, fishing, wildlife viewing, and other nature-based recreation to determine the economic benefits of these activities. Conduct a marketing assessment of current and potential nature-based tourism clients to identify user needs and wants.

- Conduct studies to determine the wants/needs/satisfaction level of constituents that participate in non-consumptive, wildlife-dependent recreation and determine the availability of sites/facilities to support that recreation.

- Inventory sites on public and private lands currently providing opportunities and access for wildlife viewing, nature and wildlife interpretation, and evaluate the potential and need for enhancing existing opportunities and access.

- Identify and inventory sites that would provide new opportunities and access for wildlife viewing and nature and wildlife interpretation.

Economic Research

- Conduct studies to evaluate the economic importance of nature tourism in Nebraska.

- Conduct research on trends in economic development and population demographics in the state and assess their potential impact on biodiversity conservation.

- Conduct research to assess the economic viability of habitat restoration. For example, evaluate the economic benefits of grazing restored wetlands compared to cropping flood-prone land.

Human Dimensions Research

- Conduct surveys to determine public attitudes towards biological diversity, conservation and management practices.

- Assess the success of methods of outreach to landowners and land managers in engaging them in wildlife-friendly practices and conservation programs.